CHAPTER 7: BOILER MAINTENANCE Part 1

We have seen that boilers are subject to a series of actions that make it necessary to attend to them carefully, especially to avoid more serious problems.
We will divide the topic into:

1. Mandatory maintenance.

2. Routine maintenance:
a) of the boiler room and outdoor boiler,
b) routine maintenance,
c) of the fire zone,
d) of the water and steam system.

3. Hydraulic inspections and tests.

1-Regulatory Maintenance

The boiler and boiler room are subject to laws and regulations that must be complied with. To this end, the boilers undergo periodic inspections (annual inspection and a hydrostatic test every four years, carried out by the relevant Ministry) and the personnel operating the boilers are monitored to ensure they hold the appropriate certification (issued by the relevant Ministry).

The minimum safety and maintenance requirements are checked during these or occasional inspections.

The room must meet minimum criteria, which fall under National, Departmental, Insurance Company (accident prevention), Fire Department, and other regulations.

It is advisable that all these regulations be compiled and kept up-to-date by the company using the boiler to ensure they are informed.

Repairs to the pressure vessel (it is advisable that these be carried out only by registered and authorized workshops), relocations, sales, etc., must be reported to the competent regulatory body.

Boilers have a logbook (issued with the initial manufacturer's certification) that must be kept in a safe place (so it is not lost), where boiler inspectors record the repairs and inspections carried out.

The boiler has a plate stamped (engraved) with the date of each inspection (stamps made only by the inspector, not by the user).

2-a) Boiler Room and Boiler Exterior Maintenance

The boiler room is the boiler operator's "home." We all like our "home" (the place where we spend 8 hours a day, many days a year, and a large part of our lives) to be clean, painted (with the colors specified by industrial safety standards), and with tools and equipment organized and readily available for any emergency.

Avoid leaving papers, rags, or tow in areas that could cause fires, as well as oil and fuel stains that can not only start a fire but also cause a slip (the well-known principle of ORDER AND CLEANLINESS).

Maintaining proper ventilation (especially if gas is used as the primary and/or secondary fuel) and adequate lighting (both natural and electric) contributes to a more comfortable and safer life.

The electrical installation must be in good working order; it is the point where fires or electrical shocks (electrical discharges) can originate, which can cause fatal shock. Electrical equipment must be properly grounded (to discharge induced or accidental voltage).

Staircases and hallways, as well as their safety railings, should be kept in good condition. These are areas where it may be necessary to walk in the dark due to insufficient light or because the room is filled with steam.

Repair all water and steam leaks (fixing valve packings and pump seals), reporting any situation you don't understand or can't handle to the supervisor.

Do not attempt repairs that could cause further damage, such as tightening a plate or threaded part under steam pressure without proper training or conditions.

Staircases and hallways, as well as their guardrails, should be kept in good condition. These are areas where it may be necessary to walk in the dark due to lack of light. Keep the boiler clean (its casing), the level indicators, and its lighting, and do not allow water or steam to fall onto the boiler (this will cause the casing to rust and pit, common corrosions on caps, plates, etc.).

2-b) The routine

-Maintain constant monitoring of **water levels and pressure**,

-**Control the fire/flame** to prevent poor combustion: smoke or excess air,

-**Purge the level controls every 4 hours** (at least once with the burner lit to check for "low level cut-off").

-Check the level of the **water supply tank**.

-Perform a **bottom purge once per shift** (every 8 hours) or as instructed, and monitor the operation of the continuous purge system (if used).

-**Add internal treatment chemicals**,

-Monitor the **water softener**, and “regenerate” it if necessary.

-**Monitor the burner** continuously, cleaning slag and nozzles (atomizing tips) as needed.

-**Monitor localized temperatures** in the boiler, chimney, and any abnormal

gas fumes leaks.

-**Monitor fuel levels**: temperatures, pressures, minimum quantities (for pumping or ordering fuel), clean filters and purge water, add additives, etc.

-In the case of **gas combustion** (natural gas or other type), **maintain leak control**, both by "smell" and by other acceptable means (leak detector, soap and water test in the joint areas, etc.).

-Perform **checks on flue gases** (visual inspections: smoke and flame color in heavy liquid fuels; in wood-burning direct combustion,

-Ensure the **flame length** does not exceed half the diameter of the cylindrical firebox.

-In Wood gasifiers/Gas generators and other gases combustion, **monitor the composition of the flue gases**, including oxygen and unburned gases or CO).

-**Check the flue gas temperature** (which can indicate that the boiler is dirty, overheating, or has other combustion problems).

-Monitor **bearing temperatures and "noises"** (abnormal vibrations), motor amperages and temperatures, tighten belts, check for oil and grease leaks, and lubricate where necessary.

This will allow us to take timely action if a failure occurs, either to make the repair or to notify the person in charge, who will arrange for the replacement or scheduled shutdown of the boiler.

-**Record any new developments** and those that the relevant person on duty needs to know to continue the journey. A form or a notebook with numbered pages is very effective for this purpose (this makes the stoker's job easier and avoids many potential misunderstandings).

-Check the safety elements, such as the safety valves, by manually opening them to the working pressure at the appropriate time (at low steam production), check the auxiliary feeding elements (pumps or injectors), purge the level indicator valves, check the fire equipment, etc.

Let's not forget that **when we start a cold boiler, we must thoroughly check the above and proceed to heat it as slowly as necessary to reach**

the working pressure (to avoid causing damage to the boiler structure, both the pressure body and refractories, since **when heated there are significant expansions: 1 mm or more per meter for every 100ºC (212°F) that the temperature rises.**

Roughly speaking, when we start a cold boiler, for a small boiler (500 kg/h of steam), start with at least one hour of low heat. Increase the heating time by half an hour for every 500 to 1000 kg/h increase in steam capacity, depending on the type of boiler (primarily the type of fuel and combustion chamber). Keep the atmospheric valve open.

Rapid heating is ultimately more expensive due to repairs or premature boiler aging (fatigue or accelerated thermal stress).

The atmospheric valve will remain open until the working pressure at which the boiler will be connected is reached. This ensures more even heating of the water mass.

In the case of boilers with a steam superheater, it will be kept in constant steam circulation by releasing steam through the discharge, ensuring that the steam circulation is not lacking (the minimum necessary to prevent the steam temperature from exceeding predetermined limits), as this can cause the boiler to "burn" due to the high temperature of the tubes.

Once the pressure is reached: slowly release steam (heating the steam distrobution pipes) and gradually increase combustion to maintain the pressure.
Monitor the internal chemical treatment, take water samples, and perform the minimum analyses necessary for good steam quality (clean and dry steam) and to prevent scale buildup and boiler corrosión.

The minimum analyses typically include:

Total Dissolved Solids, pH, and maximum and minimum values of the base products of the treatment: Phosphates, Sulfites, etc. Keep the water clear: free of suspended solids, oils, grease, etc.).

2-c) Fire zone

In this zone, we must maintain **regular cleaning** according to the type of boiler or fuel used.

Whether heavy fuel oil or heating oil, it produces a **highly insulating soot buildup** (exacerbated if combustion is inefficient).

The resulting heat loss, which increases the temperature of the flue gases (heat lost through hot gases), necessitates **periodic cleaning monitored by a thermometer in the chimney.**

This thermometer allows us to establish a maximum temperature limit for cleaning the flue pipes (brushing in smoke-tube boilers or blowing out in water-tube boilers).

These cleanings can also be scheduled by time: cleaning smoke-tube boilers every weekend, every two weeks, etc. Water-tube boilers must be blown out (with steam or air) every shift or every 24 hours, as deemed necessary.

In some cases, the chimney temperature does not reflect fouling, but rather the **pressure drop of the gases** (the gases have difficulty passing through the boiler), causing a decrease in the combustion rate due to insufficient draft.

In wood-burning boilers, the ash that adheres to the tubes also creates insulation that impedes heat transfer, which in some cases can be very significant, as the temperature of the gases increases and pressure drops.

These systems, which tend to become insulated, should be cleaned almost weekly (as in the case of gas generators, gasifiers), while in other cases, cleaning may be delayed for one or two months (direct combustion).

Ash also blocks the grates, fireboxes, and heat exchangers (air or water), causing heat insulation, but fundamentally, a loss of pressure or obstruction of the gas flow, reducing the draft to the boiler (thus limiting combustion due to lack of air).

This phenomenon is accelerated in some types of combustion and in all

when the wood has a high moisture content or has burned with insufficient air (producing a lot of CO, which indicates the expulsion of other elements through the chimney).

Therefore, grates and grates should be kept clean by removing them with the appropriate systems or by inserting compressed air bars or pipes to dislodge accumulated ash.

In gas-burning boilers, flue gas composition should be monitored, and the chimney temperature observed, as under certain conditions it can cause soot buildup that insulates the heat exchange surfaces (requiring immediate cleaning and correction of the combustion problem).

In "dual" burners (oil and gas), keep the heat exchange surface clean and remove any slag that may have formed during the period when it was used on oil (as it can be "dangerous" when switching back to gas, since there may be an ignition problem that causes a combustion chamber explosion).

Heat recovery units (air and water heaters) are easily cleaned if hot water and adequate drainage are available for the large amount of water required for cleaning.

This water can be from the feed tank, treated or untreated, but heated to over 80°C (176°F). The same feed pump can be used (with a valve for connecting the high-pressure hose), regulating the pressure to 4 to 5 kg/cm² (71 PSI) with a 1/2" nozzle.

When using hot water, and considering that the heat exchanger may be hot (since the thermal shock is minimal), be careful of burns.
Use all personal protective equipment (PPE).

2-d) Water and steam system maintenance:

Water treatment, purging, etc., are of paramount importance to prevent scale buildup or corrosion on internal surfaces.

Boilers that are stopped for days are at great risk of corrosion (mainly oxygen "pitting"), since when they lose pressure due to cooling, below 100ºC (212°F) they begin to have negative pressure (vacuum due to steam condensation) allowing air (oxygen) to enter, which with the temperature and certain conditions (the use of softened water without chemical treatment) quickly causes corrosion of the "pitting" type (mainly).

Boilers that are shut down for days are at high risk of corrosion, primarily oxygen pitting. As pressure is lost through cooling, below 100°C (212°F) they begin to experience negative pressure (a vacuum created by steam condensation), allowing air (oxygen) to enter.

This, combined with the temperature and certain conditions (such as the use of chemically untreated softened water), rapidly causes pitting corrosion (primarily).

Some boilers, used only two days a week with softened, untreated water, have developed leaks within three months of being new. Softened or condensed water (and rainwater), without proper chemical treatment, is corrosive.

We should never leave a boiler filled with this type of untreated water.

In other cases, when the boiler stops operating or due to condensate, water contamination occurs, causing corrosion that eventually perforates the boiler.

In addition to what was already mentioned **regarding oxygen pitting, these cases include boilers used for heating swimming pool water** (via heat exchangers, where water from the boiler heats the pool water).

Because these pools are chlorinated, the chlorine, upon penetrating the boiler and interacting with the internal conditions, causes pitting similar to oxygen pitting, but with an even greater corrosive effect.

PRESERVING BOILERS OUT OF SERVICE FOR LONG PERIODS

WET METHOD

When boilers are shut down for extended periods, regardless of whether their water is chemically treated, **they must be flooded with water,** leaving an elevated wáter tank working as “water seal” (to prevent air from entering and to maintain the water level despite fluctuating boiler temperature changes).

This seal should be connected to the OPEN atmospheric valve, with all other valves CLOSED.

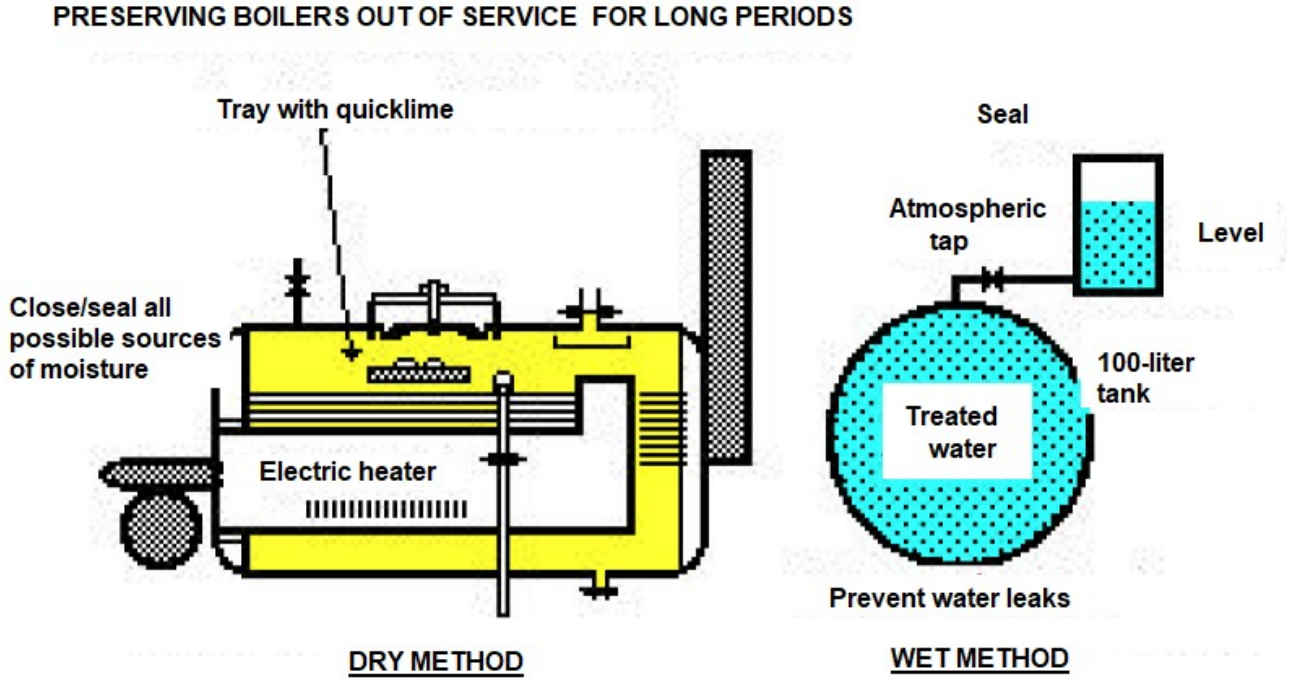
The “wáter seal”, a 20-100 liter plastic tank, should always be kept half full.

This prevents valve leaks that require refilling, as well as the possibility of steam pressure from another boiler constantly "filling" the shut-down boiler with condensate (due to valve leaks or insufficient steam retention).

DRY METHOD

It is very important to keep the boiler either flooded or completely dry. Dry it completely, with no moisture at all, using heaters or desiccant elements inside, such as quicklime or silica gel. Be careful with the lime; ¡it should not touch the metal of the boiler, as it is corrosive!

Dry boilers must be sealed to prevent moisture from entering if they do not have heaters to raise their temperature above ambient (preferably platinum-coated heaters).



BOILER CARE PERIODICITY

Boilers that are shut down must be checked periodically (every 15 days to a month) to maintain the desired conditions or values.

Boilers in operation must be opened, drained, and hosed down once or twice a year, cleaning the level controls and associated piping, checking pressure controls and their "pigtails," blowdown valves, etc.

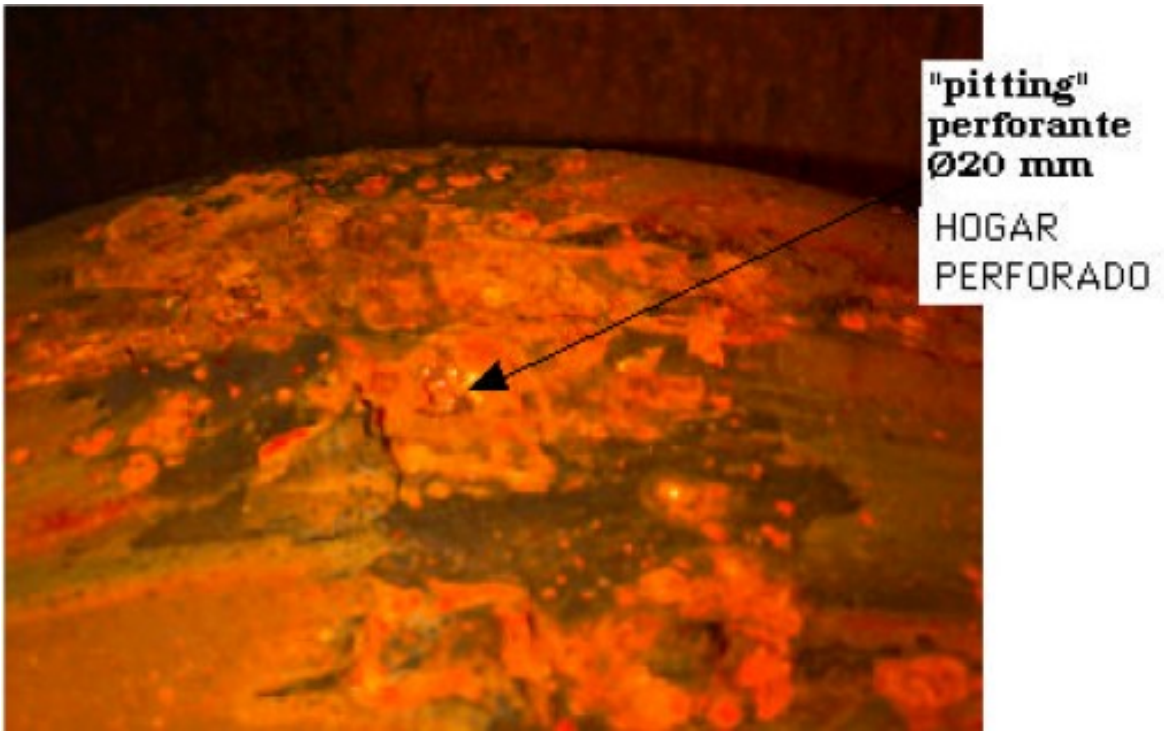
Take this opportunity to perform a visual inspection to evaluate the progress of the chemical treatment, observing for the presence of scale or sludge, corrosion, etc. (This will allow us to stop any treatment errors in time).
Replace the fusible plug (do not refill it yourself) in accordance with regulations.

CHEMICAL FEED WATER TREATMENT

Chemical treatment of boiler feed wáter isn't about "magic products"; its success depends on the skill of the boiler operator, the quality, amount and timing of the products used, and the guidance of the technician overseeing the treatment.

It's important to remember that the technician overseeing the treatment is only occasionally present at the plant and boiler room.

Therefore, the information this technician can convey to the boiler operator is of paramount importance, since the boiler operator will be the one performing the treatment and will be the only one on hand in emergencies, acting and informing the plant managers.

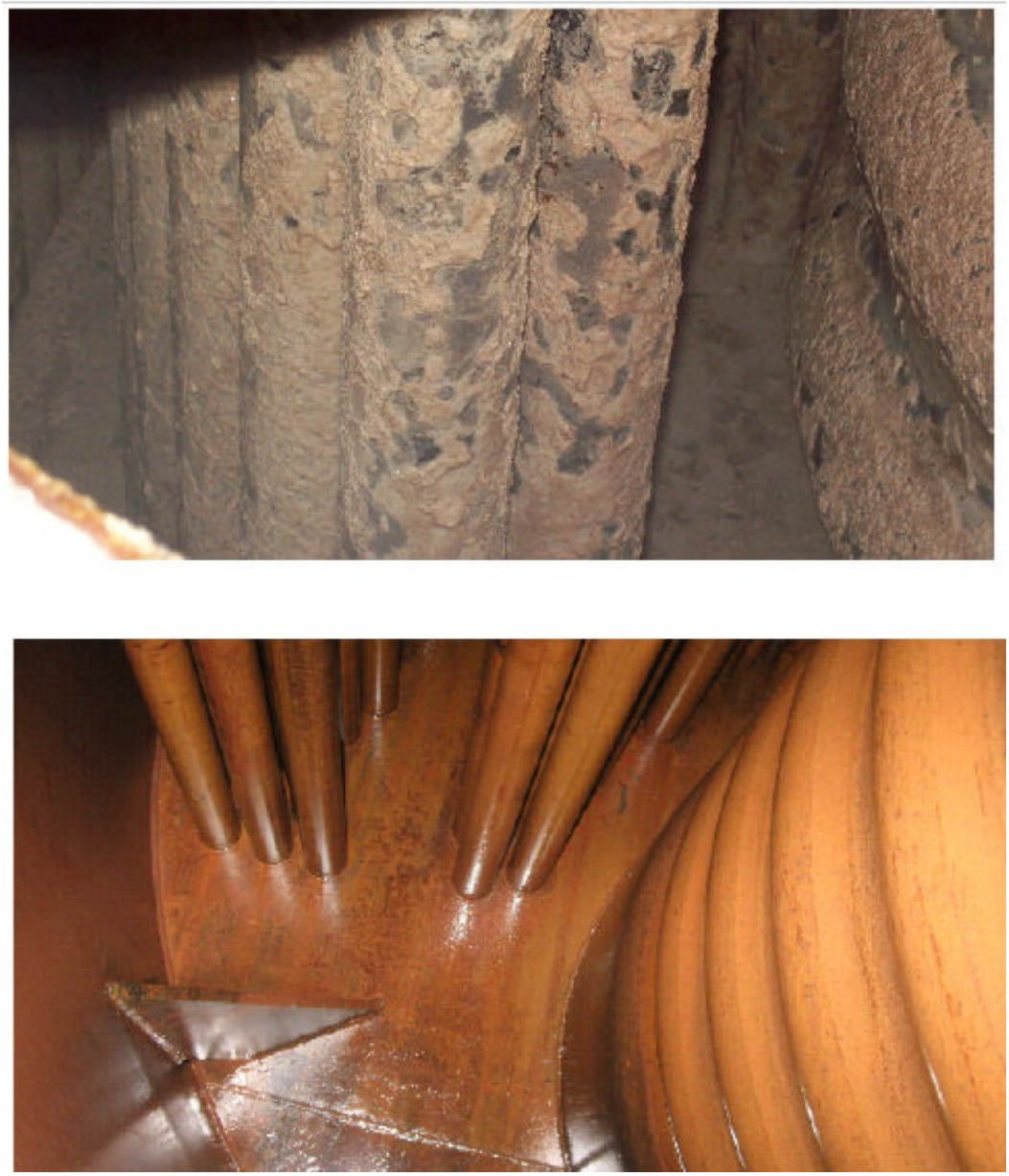


BOILER WITH "PITTING" CORROSION DUE TO POOL WATER CONTAMINATION
(New boiler, less than 1 year old; 20 mm deep pitting is observed in the boiler combustion chamber)

BOILER CHEMICAL CLEANING

It is advisable to perform a “chemical cleaning” every few years or as needed.

This chemical cleaning should be carried out by a qualified person, as it is an operation that carries risks and can cause premature aging of the boiler material (especially the tubes) or corrosion.



BEFORE AND AFTER THE CHEMICAL CLEANING
The boiler became scaled due to the use of a mixture of well water and surface water (rainwater). The boiler operator lost track of the water quality inside the boiler, and consequently, the necessary frequency of water softener regeneration and chemical dosing.

Some materials cannot withstand certain acids, and the best acids for these uses must be applied judiciously.

The experience of a qualified technician is essential previous and when performing boiler chemical cleaning, not only because of the possibility of uncontrolled corrosion or cleaning failure, but also because of the **risk of a hydrogen explosion**.

The use of acid in chemical cleaning of boiler metals causes the release of hydrogen, which, when mixed with air (oxygen), is highly explosive. In addition to other risks to human life (for those performing the chemical cleaning) and environmental hazards (spills, gases, etc.),

But if things are done properly, there's no need to fear chemical cleaning, since a boiler that is encrusted (with hard or muddy scale) not only loses performance, but also runs a great risk of "burning out," the tubes loosening on the mandrels, or the plates cracking, which becomes a permanent danger.

After chemical cleaning, the entire internal surface of the boiler must be neutralized, passivated, and mechanically cleaned (hosing and brushing if possible). Remove all scale, sludge, and other buildup.

To do this, remove all cleaning caps from the domes and collectors. Scale buildup can cause problems with water circulation and bottom valves.

After chemical cleaning (the acid neutralized, passivated, and mechanically cleaned)**, visually inspect (inside/outside) the boiler and then perform a hydrostatic test** (taking the necessary precautions to risk gases still inside, adequate ventilation as needed).

It is not advisable to attempt internal chemical treatment without knowing the condition of the boiler's internal surfaces.

DO NOT CONFUSE TERMS AND FUNCTIONS:
"WATER CHEMICAL TREATMENT" OF THE BOILER FEEDWATER WITH **"CHEMICAL CLEANING"** OF THE BOILER

While chemical treatments of the feedwater are intended to prevent scaling and corrosion, they are not for "cleaning the boiler."

Chemical feedwater treatments work by partially cleaning and removing scale deposits that obstruct the natural water circulation, causing localized overheating that, with continued operation, can damage the boiler or cause blockages in the safety system, blowdown, etc.

Given the possibility of scale or sludge buildup, it is advisable to inspect and hose down the boiler (cleaning the sludge from the bottom) as frequently as necessary. The correct approach to address this concern is chemical cleaning.

Efficiency and maximum steam production capacity are affected by the internal condition of the heat transfer surfaces: cleaning is cost-effective.

Stoker Boiler´s Handbook 2011, C.W.T. – CHAPTER 7: MAINTENANCE Part 1

For those who need to thoroughly study how to perform chemical cleaning, here are original documents of chemical cleanings carried out by my father, C.W.T.

We understand that this is a high-risk operation, both for the person performing the cleaning and for the person performing the task, and carries the risk of literally ruining a boiler.

Therefore, we felt it was not advisable to translate these C.W.T. documents from Spanish to English, but it would be a grave mistake to bury them on a hard drive running Windows 10 year 2025.

Several chemical cleaning C.W.T. (Carlos Walter Thomasset) experiences are contained here in about 10 PDF files: https://archive.org/details/limpieza-quimica-de-calderas-cwt-2008-1

It is the sole responsibility of the chemical engineer and plant technical manager to read and understand this material, its use, and its risks. 2025-12-07

Para quienes necesiten estudiar a fondo cómo realizar la limpieza química, aquí se encuentran documentos originales de limpiezas químicas realizadas por mi padre, C.W.T.

Entendemos que esta es una operación de alto riesgo, tanto para quien la realiza como para quien realiza la tarea, y que conlleva el riesgo de arruinar literalmente una caldera.

Por lo tanto, consideramos que no era aconsejable traducir estos documentos de C.W.T. del español al inglés, pero sería un grave error perderlos para siempre guardarlos en un disco duro con Windows 10 del año 2025.

Varias experiencias de limpieza química de C.W.T. (Carlos Walter Thomasset) se encuentran aquí en unos 10 archivos PDF: https://archive.org/details/limpieza-quimica-de-calderas-cwt-2008-1

Es responsabilidad exclusiva del ingeniero químico y del gerente técnico de planta leer y comprender este material, su uso y sus riesgos. 2025-12-07